Ice Road and Pad Technology – Industry Perspective

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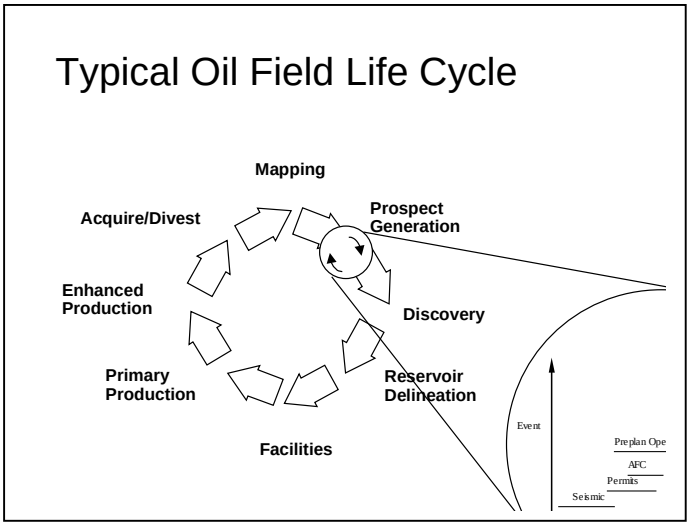
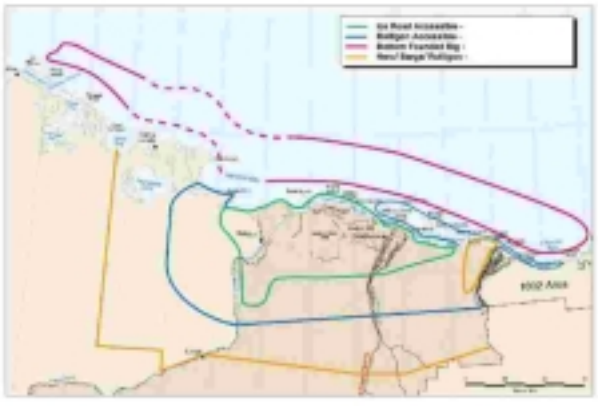


Thank you. The first thing I'm going to talk to you a little bit about ice roads in the scope of things. Then also I'll talk a little about past and present practices, some of the business drivers, some of the things we are working on to go forward, and give you a list of some of the people I work with, basically industry contacts, and then go forward from there. In the life of every oil field, you have to go through a generating process, hopefully discover something, and then go into reservoir delineation, put in your facilities, and go into primary production. After that you come in with enhanced production, and then usually you sell to another entity. In general up on the North Slope, to get from discovery to primary production in the past has taken about five years. We're continually looking at ways to decrease that cycle time.

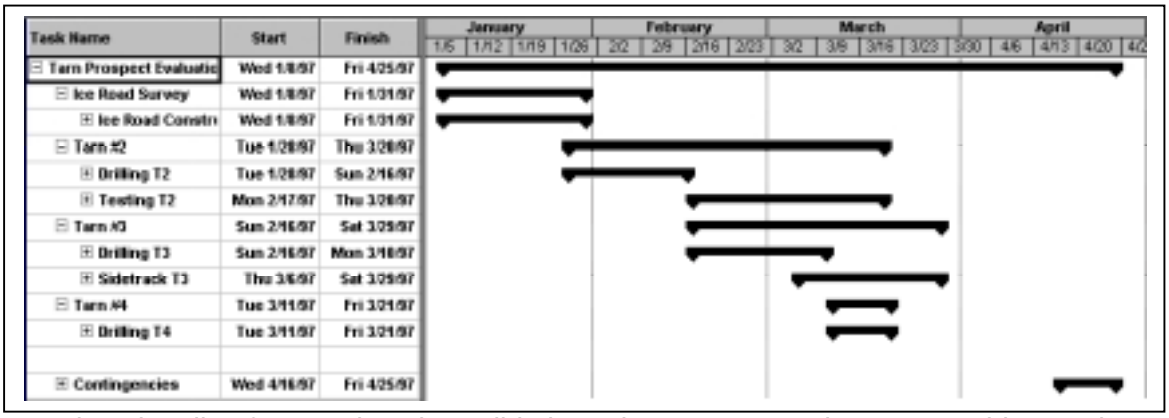
Inside of this small circle is the discovery process iteration. We have projects where we go out and do seismic work on the tundra in winter, we go through a long permitting sequence, we apply for capital to spend money and preplan. In this execution phase, a very small part is ice roads. Then afterwards we recap and learn, and then come back next year and look for new prospects.

You might ask "why doe we even use ice roads"? Basically we need to utilize our conventional wheeled supply and logistics and rig fleet that you have on the slope that works the other nine months out of the year. Instead of having special equipment that you can use for only four months of the year, we try to utilize this other equipment when possible. The other alternatives are gravel roads and pads, and mobilization and support with rolligons or C-130 Hercules aircraft

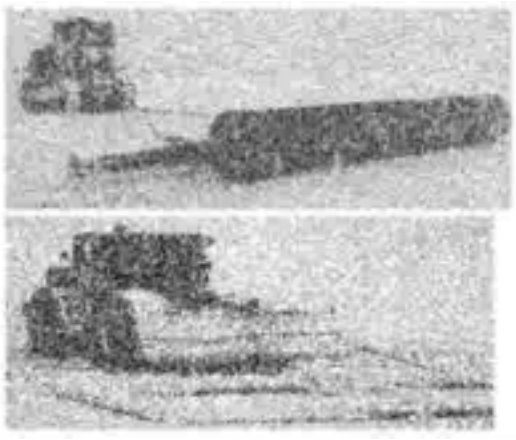


To get you oriented, this map shows the communities of Barrow and Nuiqsut on the Colville River, and also shows Prudhoe bay and the ANWR 1002 area. The green area on the map is where we use ice roads. This is outside of the infrastructure areas for Kuparuk and Prudhoe, and the new infrastructure we're starting to get

at Alpine. The area at the top of the map is where we use bottom founded rigs or floaters for working out on the water. Also the blue area on the map show where we tend to use for rolligon support, and I'll show a picture of a rolligon here in a minute and explain that. And then when we go out to the farther boundaries of the map we get out to areas where we have to take rigs apart and haul them out using Hercules aircraft.



Here is a time line for a project that I did about three years ago in 1997. In this area it took us about a month to build the ice roads. It was about 15 miles of ice road south of the Kuparuk infrastructure. Once the ice road was built, we were able to drill three wells and we discovered the Tarn prospect.



In the 60s or 70s, we didn't add a lot of water – we didn't really build ice roads. We just packed snow and basically drove on this road that was very rough, built with caterpillars and trucks. Basically any time a truck went over it, you had to go back and roll over it again, because it just kind of squooshed the snow up. So it was really a high maintenance and probably not as safe a road as we have today.

In the 70s and 80s we started adding more water, starting close to the pads because there was so much traffic around the pads. Later, we started adding more water to the roads, and graders and snow blowers were introduced to ice road maintenance. In the mid 80s we actually started adding ice chips using a machine with a big pump that threw water up into the air where it turned into snow or ice chips and deposited on the road or pad where we would pack it down. After awhile we started actually mining ice chips from lakes to use in ice road construction, and then also at that time the first insulated pads were built at the Leffingwell where insulation and boards were placed on the tundra to support the rig. Then later that insulation foam was moved over to the KIC#1 well.

Here's a picture of an ice chipper mounted on a front-end loader. Basically it has a lot of teeth, and as it moves it chips ice out into the to middle of the road as it drives over it, and then loaders come behind and put the ice chips into dump trucks and haul them to where we need them.

Using best available technology to travel across tundra with minimal impact to the environment. Rolligons.

Current practices on the Slope include the use of all terrain vehicles (ATVs). There are various types, but the one that we use a lot is the rolligon. The wheel is about five or six feet tall, and it is pretty wide. The rolligon includes equipment that can actually put air in the tires as is being driven, and the psi. rating on these tires is anywhere from 3 psi. to 12 psi. As they are going up and down the tundra, the operators can actually change the air pressure in tires.

As you can imagine, the soils of the slope have a permafrost layer that is frozen from a depth of about 1600 feet to up to maybe a foot below the surface. This top portion of the permafrost is called the active layer, and it thaws in the summer and refreezes in the winter. As soon as you dump snow on top of the active layer, there is heat trapped in that top half-foot or so, so by packing the snow you remove the air and actually promote the freezing. We do that from a rolligon, and then in time the trucks come down the middle of the road and squirt water out to the sides and start moving around on the ice road.

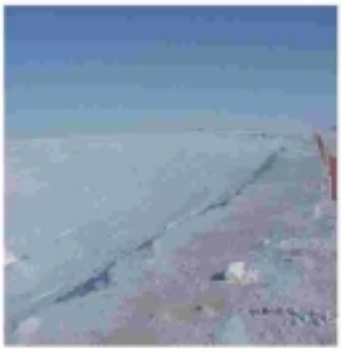
Inigok Test Well #1, 1979

I want to show you where we've come over the past 20 years. This is the Inigok Test Well #1 that was drilled by Husky in 1979 that was quite a way from any existing infrastructure. There was a road that came onto the pad, which was a gravel pad. Cuttings were dumped into a pile, and then into the reserve pit. There was also a flare pit. Well, 20 years later, this is an area that had included an ice pad and ice road.

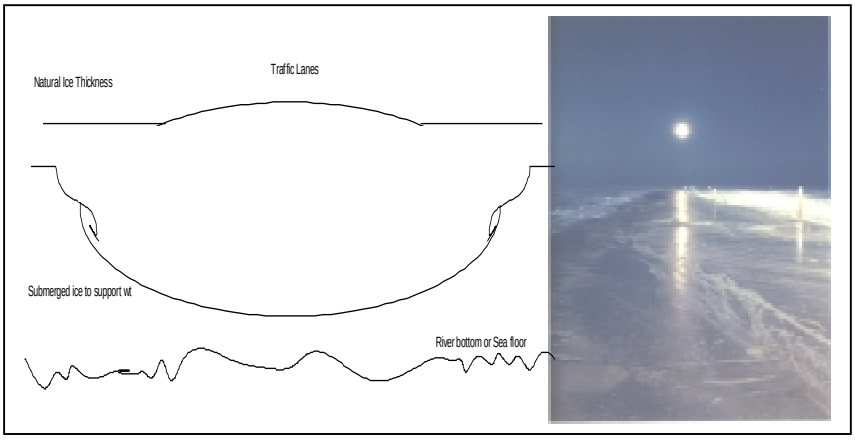
Meltwater South #1, 1999

This little mound is about the size of four of these tables put together, and is the cellar area where we dig it out at the start of the operation. Then once we abandon the operation, we abandon below ground and replace all that soil that was removed. Within five years or so, that pile of soil has all settled back down and is pretty much natural habitat.

Here is a picture of a project that we are doing today, there is actually a drilling rig on the other side of the ridge. This is the Ublutuoch Crossing, and it includes a zone with five to six foot tall willows, and is habitat for birds. The first picture was taken in about the August time frame. In the second picture, you are looking in about the same direction. You can see the ice road by the row of reflectors, and the most of the willows are covered naturally with snow. But here in the middle there is about 13 feet of ice that goes down to the bottom of the channel and is grounded. We are able to move about 1.2 million pounds of drilling rig across that bridge. That bridge in round numbers cost about $500,000, and took about three weeks of labor. You usually lay it in six-inch drifts.



Here is the cross section of an ice bridge if you can cut it in half and look into the ice bridge as you are going down the road. In the middle are the truck traffic lanes. We go out and we add maybe 100 to 150 ft of ice on both sides, and it's just like putting ice cubes into a glass of water, ten percent of it stays on top of the water while 90 percent of it goes down into the water. Throw in another ice cube and it sinks down the same way. What happens here is that as you add more and more ice on top, you create a bulb down in the bottom of the channel. This eventually creates a big enough structure that it will handle the weight that you design the road for. Sometimes they ground, but a lot of times they don't, and this could be over the bottom of the sea floor or a river bottom.



Ice roads are not the answer to everything we do up on the Slope - there are some limitations. The Meltwater South location that I showed you a few minutes ago could have gone another 5 to 10 miles south, but then there are not enough water sources to build an ice road. It costs too much money to haul water from the water sources. So you need water sources, and you need reasonable topography. Looking back at that Ublutuoch Crossing, if you had five of those crossings for a project, you really couldn't afford to do it.

The road quality is also important. You build the roads for what the loads are going to be. If the loads are too large, you won't be able to use the roads. The length of the road needed is also a factor, as the longer you take to get out to where you are going is just time taken away from your actual operation to drill. This runs into problems with season length.

Finally, there is what I call the Economy of Scale. When we find fields, even small fields on the North Slope, they need to be really large fields compared with fields in Texas or California. But they still have to be the right size for us to go out and drill.

So for Business Drivers, the main thing is that we maintain an environmental focus. We want to preserve the environment. We also want to reduce cycle time, and get the oil to the market sooner than our competitors. And the finding costs on the Slope need to be very competitive to attract capital, because the development costs on the North Slope are so very high compared to other places in the world.

So in the future we are going to be under pressure to maximize season length. To do this, we need to be looking at insulating pads, and we are also hoping to work with the agencies toward a tiered approach to tundra opening. We'd like to look at ways to increase bridge strengths with new kinds of materials. And we want to continue to monitor fish habitats. We have scientists come up to look at the lakes and tell us what we have. We also invite the local leaders from Nuiqsut or elsewhere. We are always monitoring the fish habitat. And there are the water recharge studies. We have a lot of reserve pits out on the Slope, and every year they fill up with water and we have to pump them out just so they won't overflow.

- Ben Cleveland - Peak Oilfield Service Co.
- Beez Hazen - Northern Eng. & Scientific
- Bob Lewellen - Lewellen Arctic Research
- Bill Kuper - CATCO
- Dan Masterson - Sandwell Engineering
- Jim Palmeteer - SKW/Eskimos, Inc.
- Bill St. Lawrence - Polar Alpine

This is a list of the people I work with, if you are interested in contacting people to talk about ice roads and ice pads

I wanted to put ice roads in perspective for you. I've talked a little bit about practices, the business drivers behind what we are doing, and where we're going in the future, and have given you a list of contacts. I also want you to go away with the message that topography and renewable water sources are important, that we need to cooperate between industry and agencies, and that we are continuously looking for better ways, through improved technologies

I want to leave you with this picture of a 3.4 million-pound production module in transit on an ice road to the Alpine site. This one happens to be on the sea ice. They crossed about 10 ice bridges and about 40 miles of ice roads, and all these roads and bridges will disappear in about two months.

Thank you.